Science.

Technology.

Innovation.

# Electricity Infrastructure Operations Center

## Advancing technologies for the integrated energy system

Pacific Northwest National Laboratory introduces the Electricity Infrastructure Operations Center (EIOC), a new user-based facility dedicated to energy and hydro power research, operations training and back-up resources for energy utilities and industry groups.

As a Department of Energy research facility focused on energy, environmental, national security, fundamental and computational sciences, PNNL's expertise in multiple scientific disciplines uniquely supports the Center's interests. Located on the Laboratory's Richland, Washington campus, the EIOC was developed in partnership with the Northwest Center for Electric Power Technologies (NCEPT) and industry partners with the goal of strengthening the grid system.

The facility brings together experts in the field of grid management and research with cutting-edge tools to create a central resource for improving grid control, operations and security. As a platform for energy system research and development, the EIOC's founding philosophies are to encourage the leveraging of tools and facilities by utilities and industry, expand research and to facilitate collaboration.

### State-of-the art facility

The EIOC, designed by the Mauell Corporation, features several best-in-class tools for demonstration, testing, research, and operation of energy systems.

**The EIOC, located at the Pacific Northwest National Laboratory in Richland, WA was commissioned in June 2006.**

**Pacific Northwest National Laboratory**
Operated by Battelle for the U.S. Department of Energy

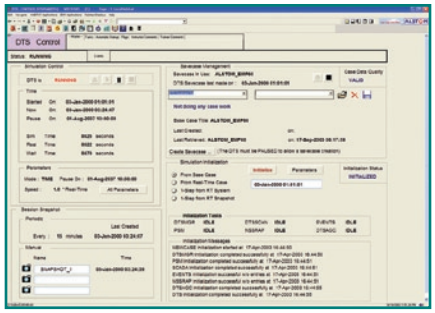
**Display technology** - A 23-foot wide video wall system, developed by Clarity Visual Systems, provides seamless visualization of incoming data from multiple sources such as Supervisory Control and Data Acquisition (SCADA) data, phasor data, market information, environmental information, and other sources. Integrated with the National Visualization and Analytics Center™ (NVAC), the system provides advanced visualization of power system operation so analysts can better maintain system-wide health, prevent security breaches and prepare for energy demand influxes.

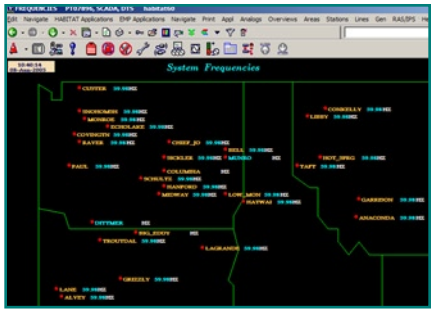
**EMS software** - The control center operates with a multi-million dollar energy management system (EMS) software package from leading developer AREVA T&D. The software provides a foundation for the EIOC's users, enabling utility data to be imported from major regional utilities to allow more accurate planning for consumer power needs. The EIOC collects data from private and public utilities, which provides a basis for conducting research on current data.

## A collection of capabilities

The EIOC bridges the capabilities of today's grid control center to tomorrow's energy operations, which involve a more complex set of resources and enhanced operating paradigms. Not only does the EIOC help define the current performance of the overall energy system, the Center also focuses on how specific technologies or other operational changes can improve it. Specific capabilities of the EIOC include:

**Grid research and development platform.** The EIOC is a working grid operations center, complete with live data feeds from actual utility SCADA systems. It contains the computer hardware, operator consoles and displays, communications links, and display and control software suitable for managing the transmission and sub-transmission networks of regional utilities. Emerging technologies in grid analysis, advanced visualization, cyber security, high-performance computing, and techniques in human factors can be applied within the EIOC in an operational testbed environment.





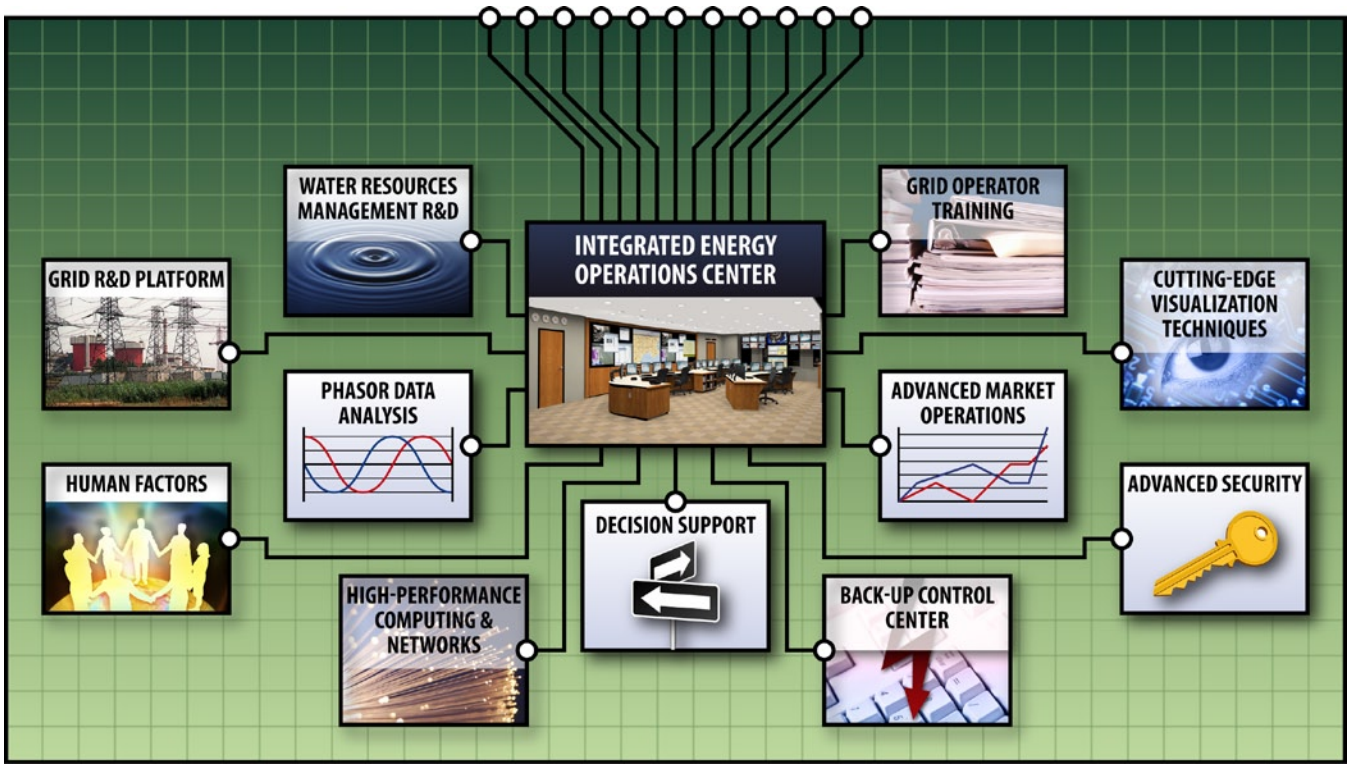

**The EIOC incorporates energy management system (EMS) software and other new and existing tools for managing the energy system.**

**Grid operator training.** The EIOC's control center capability can be leveraged to provide training for grid operators. Training can range from basic and refresher courses for operator licensing to advanced training in the use of new technologies for the grid or its control, data from new kinds of sensors, national security-related contingencies and procedures, and advanced visualization and computational techniques.

**Advanced security.** The Center integrates the latest in communications security such as recent developments in serial data authentication and new concepts generated from the Intrisically Secure Computing™ research center. The long range goal of the ISC is to protect infrastructures with a trusted base, adaptive defenses, and appropriate responses while incorporating self-organizing, self-healing, and self-optimizing processes.

**Hydro resources management R&D.** The EIOC has live data feeds from a variety of sources encapsulating meteorological data, flows, reservoir levels, snow cover, and electricity demand to provide researchers with a critical framework from which to develop improved tools and methods. The information provides for development and testing of improved methods for streamflow forecasting and management to better manage hydropower operations while maintaining environmental, agricultural, and recreational water uses.

**The EIOC includes state-of-the-art water resources management tools that can be used to optimize hydroelectric power production while maintaining other water uses.**




**High-performance computing and networks.** The EIOC is the first control center environment to demonstrate the ultra high-speed computational capabilities that make state estimation and contingency analysis processes run at speeds only capable with modern super computers. Connection to the Energy Sciences Network (ESnet) provides ultra high-speed access to DOE and other collaborators.

**Phasor data analysis.** By displaying real-time phasor data representing grid conditions nationwide, the EIOC supports wide-area measurement systems (WAMS) for the western grid and further deployment of the Eastern Interconnection Phasor Project (EIPP) for the DOE. Regional phasor data networks are a way for grid control centers to maintain "over-the-horizon" situational awareness of conditions in neighboring control areas. They also form a foundation for meeting Federal needs for homeland security and emergency management capabilities.

**Backup control center.** By providing and continually updating their system models, participating utilities can use the EIOC as a backup center to meet Federal Energy Regulatory Commission requirements in an emergency. Being a secure environment, the EIOC can provide shared computation facilities that can reduce regional utility costs in recovering from an emergency.

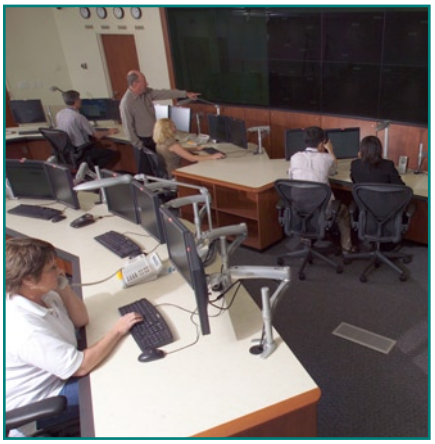
**Human factors.** The EIOC incorporates various elements of human factor concepts, research and training into its core mission. These technologies focus on situational awareness, cognitive representations (mental models), socio-technical elements such as trust in people and systems, communication engagement and semantics, and traditional issues including workload and ergonomics.

**Access to real-time phasor data allows over-the-horizon visibility of the enitire power grid.**

## Looking to the future

As the user-base for the EIOC grows, additional capabilities and facility expansion are expected. These plans will position the EIOC as a national center for grid research and control. A few of these concepts include:

**Cutting-edge visualization techniques.** As grid telemetry becomes richer and more prolific, operators are faced with the complex task of quickly gleaning information from more and more complex sets of data. The data which was intended to help them operate the grid more securely requires far too



**The EIOC provides a testbed environment for the latest operational techniques and grid technologies.**

much interpretation to be of practical use. For example, most grid operators with access to real-time high speed grid telemetry (referred to as phasor data) do not utilize it. In order to exploit the potential usefulness of this data for operators, it must be converted into actionable information and efficiently presented to the operators in the proper context.

If operators ignore phasor data and other new types of data sets that become available, such technology advances will provide limited benefit to operational security. The presentation of these data sets will ultimately become a distraction, actually diminishing grid security. High performance computing can be used with advanced visualization analysis to present context-based information to grid operators, providing them with a better operational understanding of the system. Used in conjunction with wide-area telemetry and real-time analysis, high performance computing will be required to meet this need.

PNNL leads the National Visualization and Analytics Center for the Department of Homeland Security (http://nvac.pnl.gov/). Access to this unique program and research makes the EIOC an ideal environment for exploring alternative visualization technologies of an ever increasingly complex power grid.

**Advanced market operations.** In the future, grid operations will rely as much on indirect, market-based "control" of customer and third-party resources as they will on direct control of grid assets. The GridWise™ demonstration project on Washington State's Olympic Peninsula has a fully operational shadow market dispatching residential, commercial, and industrial demand response, as well as industrial and commercial facility backup generators for grid benefits that are managed by the EIOC network. The Center's resources are used to balance the supply-side in wholesale markets, relieve transmission congestion, provide ancillary services, and avoid or defer distribution capacity expansion. Additionally, the EIOC is able to monitor the markets for these services and the response of individual homes and businesses to them, and portrays their performance and impact in essentially real-time over a web-based interface. The EIOC is leveraging this near-term, project-funded effort to portray a "market operations center" as an integral part of the future grid.

Additional expansion opportunities will involve improved testing facilities for grid technologies, use of PNNL-developed web-based control interfaces, and other projects directed at lower customer energy costs and improving grid performance.

**Access to Pacific Northwest National Laboratory's supercomputer and the high-speed connection to the Energy Sciences Network allows the EIOC to develop, test and demonstrate new technologies.**

## About PNNL

PNNL (www.pnl.gov) is a DOE Office of Science laboratory that solves complex problems in energy, national security, the environment and life sciences by advancing the understanding of physics, chemistry, biology and computation. PNNL employs more than 4,200 staff, has a $725 million annual budget, and has been managed by Ohio-based Battelle since the Lab's inception in 1965.

GRIDWISE

Intrinsically Secure Computing Research Center

NCEPT

NATIONAL VISUALIZATION AND ANALYTICS CENTER NVAC

**The EIOC draws upon the expertise and capabilities of many organizations and entities, including DOE's Gridwise program, the Northwest Center for Electric Power Technologies, and the Department of Homeland Security's National Visualization and Analytics Center.**

**For more information about the EIOC, contact**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